CRITICAL PATH ROADMAP DISCIPLINE(S) Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss	SPECIES / TYPE Animal Animal	SPACE FLIGHT EXPERIMENT TITLE Adaptive Response of Slow and Fast Skeletal Muscle in the Monkey to Spaceflight An Evaluation of Collagen Metabolism in Non-Human Primates associated with the BION	1995 1995	Year 1996 1996	r Exper 1997	iment \ 1998	Was Lis 1999	ted in I	300k 2001	2002
Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss	Animal		_		<u>1997</u>	<u>1998</u>	<u>1999</u>	2000	2001	2002
Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss			1995	1006						2002
Bone Loss Muscle Alterations & Atrophy; Bone Loss Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss	Animal	An Evaluation of Collagen Metabolism in Non-Human Primates associated with the BION		1770						
Bone Loss Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss		Space Program-Markers of Urinary Collagen Turnover and Muscle Tissue Collagen Types			1997	1998	1999			
Muscle Alterations & Atrophy Muscle Alterations & Atrophy; Bone Loss	Animal	Bone and Lean Body Mass Changes Following Space Flight	1995	1996	1997	1998	1999			
Muscle Alterations & Atrophy; Bone Loss	Animal	Development of Sensory Receptors in Skeletal Muscle	1995	1996	1997	1998				
Bone Loss	Animal	Effect of Gravity on the Attachment of Tendon to Bone	1995	1996	1997	1998				
Mussle Alteretions & Atanaha						2,,,,				
Muscle Alterations & Atrophy	Animal	Effect of Microgravity on Rat Masseter Muscle	1995							
Muscle Alterations & Atrophy	Animal	Effect of Weightlessness on Single Muscle Fiber Function in Rhesus Monkeys	1995	1996	1997	1998				
Muscle Alterations & Atrophy	Animal	Effects of Microgravity on Neuromuscular Development	1995	1996	1997	1998	1999	2000		
Muscle Alterations & Atrophy;	Animal	Effects of Microgravity on Postnatal Motor Development	1995	1996	1997	1998	1999	2000		1
Neurovestibular Adaptation		Dec . co Pi i M i iv	1007	1006	1005	1000				
Muscle Alterations & Atrophy	Animal	Effects of Space Flight on Muscles and Nerves Effects of Space Flight on Neuromuscular Development	1995	1996 1996	1997	1998				
Muscle Alterations & Atrophy Muscle Alterations & Atrophy;	Animal Animal	Expression of Contractile Proteins in Microgravity	1995	1996	1997	1998	1999			
Cardiovascular Alterations	Aiiiiiai	Expression of Contractic Froteins in wherogravity	1993	1990	1997	1990	1999			
Muscle Alterations & Atrophy	Animal	Flight Verification Test of Nursing Facility (Dr. Riley)	1995	1996	1997	1998				
Muscle Alterations & Atrophy	Animal	Flight Verification Test of Nursing Facility (Kerry D. Walton, Ph.D.)		1996	1997	1998				
Muscle Alterations & Atrophy	Animal	Functional Neuromuscular Adaptation to Spaceflight	1995	1996	1997	1998	1999			
Muscle Alterations & Atrophy;	Animal	Mitochondrial Changes in Muscle Following Space Flight (Martin)	1995							
Cardiovascular Alterations	A. dinast	Model in the state of the state	1007	1006						<u> </u>
Muscle Alterations & Atrophy	Animal	Morphological, Histochemical, Immunocytochemical, and Biochemical Investigations of Spaceflight-Related Nerve and Muscle Breakdown	1995	1996						
Muscle Alterations & Atrophy	Animal	Neuro-Thyroid Interaction on Skeletal Isomyosin Expression in 0 g	1995	1996	1997	1998	1999	2000		
Muscle Alterations & Atrophy;	Animal	Skeletal Development in Long Duration Spaceflight	1995	1996	1997	1998				
Bone Loss										
Muscle Alterations & Atrophy;	Animal	The Effect of Spaceflight on Cartilage Cell Cycling and Differentiation			1997	1998	1999			
Bone Loss	0.11	T20 - 20 T - 1 (1 1 1 1 1 1 7 1 (22 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1								<u> </u>
Muscle Alterations & Atrophy	Cells	Effect of Space Travel on Skeletal Myofibers (9304010)	1995	1996	1997	1998	1000	• • • • •	****	
Muscle Alterations & Atrophy	Cells	Effect of Space Travel on Skeletal Myofibers (9604496)	1007	1006		1998	1999	2000	2001	2002
Muscle Alterations & Atrophy Muscle Alterations & Atrophy	Cells Human	Molecular and Cellular Analysis of Space Flown Myoblasts Anticipatory Postural Activity During Long-Duration Space Flight	1995 1995	1996 1996	1997	1998	1999			\vdash
Muscle Alterations & Atrophy;	Human	Bed Rest Study (ground based for LMS)	1995	1996	1997	1998	1999			
Bone Loss	Truman	Bed Rest Study (ground based for EMS)	1993	1990						1
Muscle Alterations & Atrophy;	Human	Bone Mineral Loss and Recovery After Shuttle/MIR Flights	1995	1996	1997	1998	1999			
Bone Loss	TT	FCC at a CD and a seed Consequently and Thomas Challeted Manufacture				1000	1000	2000	2001	2002
Muscle Alterations & Atrophy Muscle Alterations & Atrophy	Human Human	Effect of Prolonged Spaceflight on Human Skeletal Muscle Effect of Spaceflight on Human Skeletal Muscle Force Per Cross-Sectional Area:				1998	1999 1999	2000	2001	2002
Muscle Alterations & Attophy	пишап	Architectural, Contractile and Neural Determinants					1999			
Muscle Alterations & Atrophy	Human	Effect of Weightlessness on Human Single Muscle Fiber Function	1995	1996	1997	1998	N/A	N/A	2001	
Muscle Alterations & Atrophy;	Human	Evaluation of Skeletal Muscle Performance and Characteristics (NASA-Mir Phase1B)	1995	1996	1997	1770	14/21	14/21	2001	
Clinical Capabilities		,		-,,,						
Muscle Alterations & Atrophy; Clinical Capabilities	Human	Evaluation of Skeletal Muscle Performance and Characteristics (SLM-1A)	1995	1996						
Muscle Alterations & Atrophy;	Human	Foot Reaction Forces During Space Flight				1998	1999	2000	2001	2002
Bone Loss;		Ü i								
Clinical Capabilities										
Muscle Alterations & Atrophy;	Human	Magnetic Resonance Imaging after Exposure to Microgravity (284054);	1995	1996	1997	1998				
Bone Loss		Magnetic Resonance Imaging After Exposure to Microgravity (9401586)								<u> </u>
Muscle Alterations & Atrophy;	Human	Measurement of Energy Expenditures during Spaceflight Using the Doubly Labeled Water	1995	1996	1997	1998				
Clinical Capabilities;		Method								
Food & Nutrition Muscle Alterations & Atrophy	Llumon	Migro Gravity Induced Changes in the Central of Misseles						2000	2001	2002
Muscle Alterations & Atrophy Muscle Alterations & Atrophy	Human	Micro-Gravity Induced Changes in the Control of Muscles Morphological Histochemical and Ultrastructural Characteristics of Skeletal Muscle	1005	1006				2000	2001	2002
Muscle Alterations & Atrophy;	Human Human	Morphological, Histochemical, and Ultrastructural Characteristics of Skeletal Muscle Protein and Energy Status During Long-Term Space Flight	1773	1996			1999	2000		
Clinical Capabilities;	Tuman	rotem and Energy Status During Long-reint space Fright					1,777	2000		
Food & Nutrition										
Muscle Alterations & Atrophy;	Human	Protein Metabolism During Long Term Space Flights	1995	1996	1997	1998	1999			
Clinical Capabilities;										
Food & Nutrition										
Muscle Alterations & Atrophy;	Human	Protein Turnover During Space Flight			1997	1998	1999	2000	2001	2002
Clinical Capabilities;										
Food & Nutrition										
Muscle Alterations & Atrophy	Human	Pyruvate Supplementation on Muscle Metabolism	1005	1007	100=	1000				
Muscle Alterations & Atrophy; Neurovestibular Adaptation	Human	Relationship of Long-Term Electromyographic (EMG) Activity and Hormonal Function to Muscle Atrophy and Performance	1995	1996	1997	1998				
Muscle Alterations & Atrophy;	Human	A Low Intensity Mechanical Countermeasure to Prohibit Osteoporosis in Astronauts								2002
Bone Loss;	Tulliali	During Long-Term Spaceflight								2002
Clinical Capabilities		Same Long Term opacement								